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Boreonectes gen. n., a new genus for the *Stictotarsus griseostriatus* (De Geer) group of sibling species (Coleoptera: Dytiscidae), with additional karyosystematic data on the group

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Abstract. A new genus, *Boreonectes* gen. n., is erected for the seven *S. griseostriatus*-group species as well as eight other American ones listed by Nilsson and Angus (1992) as comprising the *Stictotarsus griseostriatus*-group as DNA work by Ribera (2003) shows this arrangement to be untenable, and no other genus-group name has been found to be available. Chromosomal investigations have shown that *B. griseostriatus* (De Geer, 1774) occurs as far west as the Little St Bernard Pass in the Alps, with *B. alpestris* (Dutton et Angus, 2007) in the Italian Gran Paradiso National Park to the south of this. *B. multilineatus* (Falkenström, 1922) is recorded from the Pyrenees for the first time, and *B. ibericus* (Dutton et Angus, 2007) is shown to be present in the Moyen Atlas of Morocco.

Key words: Dytiscidae, *Boreonectes*, new genus, *S. griseostriatus* group, sibling species, chromosomes, distributions, Alps, Pyrenees, Morocco.

Introduction

The Generic Placement. One of the most unsatisfactory features of the *Stictotarsus griseostriatus* (De Geer, 1774) species-group is its placement within the genus *Stictotarsus* Zimmermann, 1919. Nilsson and Angus (1992), in an attempt to sort out confusion concerning the classification of the Dytiscid genera related to *Deronectes* Sharp, 1882, placed those species not in *Deronectes*, but with parameres lacking the apical hook, in *Stictotarsus*. They divided *Stictotarsus* into three species groups, the *S. duodecimpustulatus* (Fabricius, 1792) group (true *Stictotarsus*) and the *S. griseostriatus* and *S. roffi* (Clark, 1862) groups. These were left as informal groupings as no synapomorphies were found for the *S. griseostriatus* group. This arrangement at present stands, but has never been popular with coleopterists (e.g. Mazzoldi and Toledo, 1998). Then Ribera (2003) published a paper giving the results of mitochondrial DNA analyses which rendered Nilsson and Angus' arrangement untenable. The *Stictotarsus duodecimpustulatus* group was shown to come out on phylograms near *Nebrioporus* Regimbart, 1906 and *Scarodytes* Gozis, 1914, while *S. griseostriatus* (sensu lato), along with *S. striatellus* (LeConte, 1852) (also in the *S. griseostriatus* group) and *S. roffi* came out between two sections of *Oreodytes*

Seidlitz, 1887. *Trichonectes otini* Guignot, 1941, included in the *S. griseostriatus* group by Nilsson and Angus, was shown to come out basal to the *Stictotarsus* (*duodecimpustulatus*-group) - *Nebrioporus* - *Scarodytes* clade, thus taking it right out of the *S. griseostriatus* group and rendering the generic name *Trichonectes* Guignot, 1941 unavailable for the *S. griseostriatus* group.

If the present unsatisfactory classification of the *S. griseostriatus* group is to be remedied, then at present there appear to be two alternative courses of action. One is to place the *S. griseostriatus* group (and probably also the *S. roffi* group) within an expanded *Oreodytes*. The other is to erect a new genus for the *S. griseostriatus* group of species. Neither course is without its pitfalls. *Oreodytes* is not regarded as one of the *Deronectes* group of genera (Deronectina), differing, among other ways, in having contact between the median keel of the metasternum and the mesosternal fork, and sucker-hairs on the anterior and middle tarsi of the males. Such hairs are widespread among Hydroporini but lacking in Deronectina (Nilsson and Angus, 1992). To place the *S. griseostriatus* group within *Oreodytes* would almost certainly simply result in a short-term change of name, to be altered later.

The second course of action, to be adopted here, is to erect a new genus for the S. *griseostriatus* group of species. The pitfalls here are firstly that the exact limits of the new genus must remain to be established, and secondly that, assuming the DNA phylograms are correct, *Oreodytes* becomes a paraphyletic genus. The limits of genera are always subject to revision as more knowledge becomes available, so that objection does not seem overriding. As to *Oreodytes*, if more work is needed to sort out its composition, that is a separate task awaiting further research. The new genus may now be described.

Boreonectes gen. n. Type species: *Dytiscus griseostriatus* De Geer, 1774. Hydroporine beetles with the *Deronectes* group characters of the median keel of the metasternum not touching the mesosternal fork and absence of sucker-hairs on the fore and middle tarsi of the males. Parameres more or less similar, of the *Hydroporus* pattern, without any apical hook or other sclerotised apical section. Ventral surface of adults densely and finely punctate, without visible reticulation between the punctures. Elytra densely and finely punctured, without reticulation between the punctures (except in *Hydroporus panaminti* Fall, 1923, q.v.), the primary series of larger punctures indistinct or very prominent, depending on species. Ventral surface of head behind the eyes shining, with superficial reticulation. Pronotum without distinct lateral grooves or depressions. Larvae with well-developed swimming-hairs on the legs, these in most cases extending on to the tarsi, including those of the anterior legs. Urogomphi of second and third instar larvae with numerous secondary setae on the basal segment, this very long, 90% + of the total length of the urogomphus in third instar larvae.

Differential diagnosis. Median keel of metasternum not touching metasternal fork; fore and mid tarsi of males without sucker-hairs; parameres of the *Hydroporus* pattern, without apical hook or other sclerotised apical portion; ventral surface of head behind eyes shining, with only superficial reticulation (closely punctate in *Stictotarsus* and the *S. roffi* group); ventral surface of body finely and densely punctate, without visible reticulation between the punctures; urogomphi of second and third instar larvae with numerous secondary setae (absent in *Deronectes*).

The etymology of the name is from the Greek Boreas, the North, and Nectes, a

Table 1. Material used for chromosomal analysis.

Species	Locality	Number of specimens analysed
B. griseostriatus (De Geer)	Switzerland, Valais, Lake by the Illsee	1♂
	France, Col du Petit Saint-Bernard, pool at 2200 m a.s.l., SW of la Baraque des Douaniers (Fig. 1).	2 ♀♀
	Italy, Colle del Piccolo San Bernardo, pools between the French frontier and the NE edge of Lac Verney (Fig. 1).	1♂, 2♀♀
B. multilineatus (Falkenström)	France, Hautes-Pyrénées, Barèges, 2245 m. a.s.l. Pond south of the Lac d'Oncet. Leg. F. Bameul (Fig. 2).	2♂♂, 3♀♀
B. alpestris (Dutton et Angus)	Italy, Piemonte, Gran Paradiso National Park. Colle del Nivolet, roadside lake at ca 2500 m. a.s.l. (Fig. 1).	7♂♂, 2♀♀
B. ibericus (Dutton et Angus)	Morocco, Moyen Atlas, Khenifra Province, roadside pool ca 1 km N of Col du Zad, 2150 m a.s.l. (Fig. 2).	2♂♂, 5♀♀

swimmer. It refers to the mainly northern distribution of *Boreonectes griseostriatus*.

Included species: *Boreonectes* may be expected to include most of the species listed by Nilsson and Angus in the *S. griseostriatus* group, with the proviso that as new information becomes available species may be excluded, as has happened with *Trichonectes otini*. Based on Nilsson and Angus (1992), this gives the following 15 species: The *B. griseostriatus* group – *Dytiscus griseostriatus* De Geer, *Potamodytes multilineatus* Falkenström, *Potamonectes macedonicus* Georgiev, 1959, *Stictotarsus alpestris* Dutton et Angus, 2007, *S. ibericus* Dutton et Angus, 2007, *S. inexpectatus* Dutton et Angus, 2007 and *S. riberae* Dutton et Angus, 2007 (seven species), plus *Hydroporus aequinoctialis* Clark, 1862, *H. coelamboides* Fall, 1923, *Deronectes dolerosus* Leech, 1945, *Hydroporus expositus* Fall, 1923, *H. funereus* Crotch, 1873, *H. panaminti* Fall, 1923, *Deronectes spenceri* Leech, 1945 and *Hydroporus striatellus* LeConte, 1852. The inclusion of *H. panaminti* may be regarded as tentative because the elytral punctation of this species, though fine, is more diffuse than in the others, and the space between the punctures is finely reticulate.

The phylogram given by Ribera, 2003 on p 484 associates the *S. roffi* group with the *griseostriatus* group, though slightly separate from it. These beetles were shown by Nilsson and Angus to have a somewhat different morphology, with contact, apparently secondary, between the median keel of the metasternum and the mesosternal fork, and the ventral surface of the head, behind the eyes, rugosely punctate, so for the moment it seems better to exclude them from *Boreonectes*. The general appearance of the *S. roffi* group species is distinctly different from those included in *Boreonectes*. It should be noted that *Boreonectes* is an overwhelmingly Nearctic genus, with only the *griseostriatus* group extending into the Old World.

An ongoing programme of karyosystematic investigation of the *Boreonectes griseostriatus* group of sibling species (Dutton, Angus, 2007; Angus, 2008 and Angus, 2010) is clarifying the taxonomic status and distributions of the various species involved. The investigations

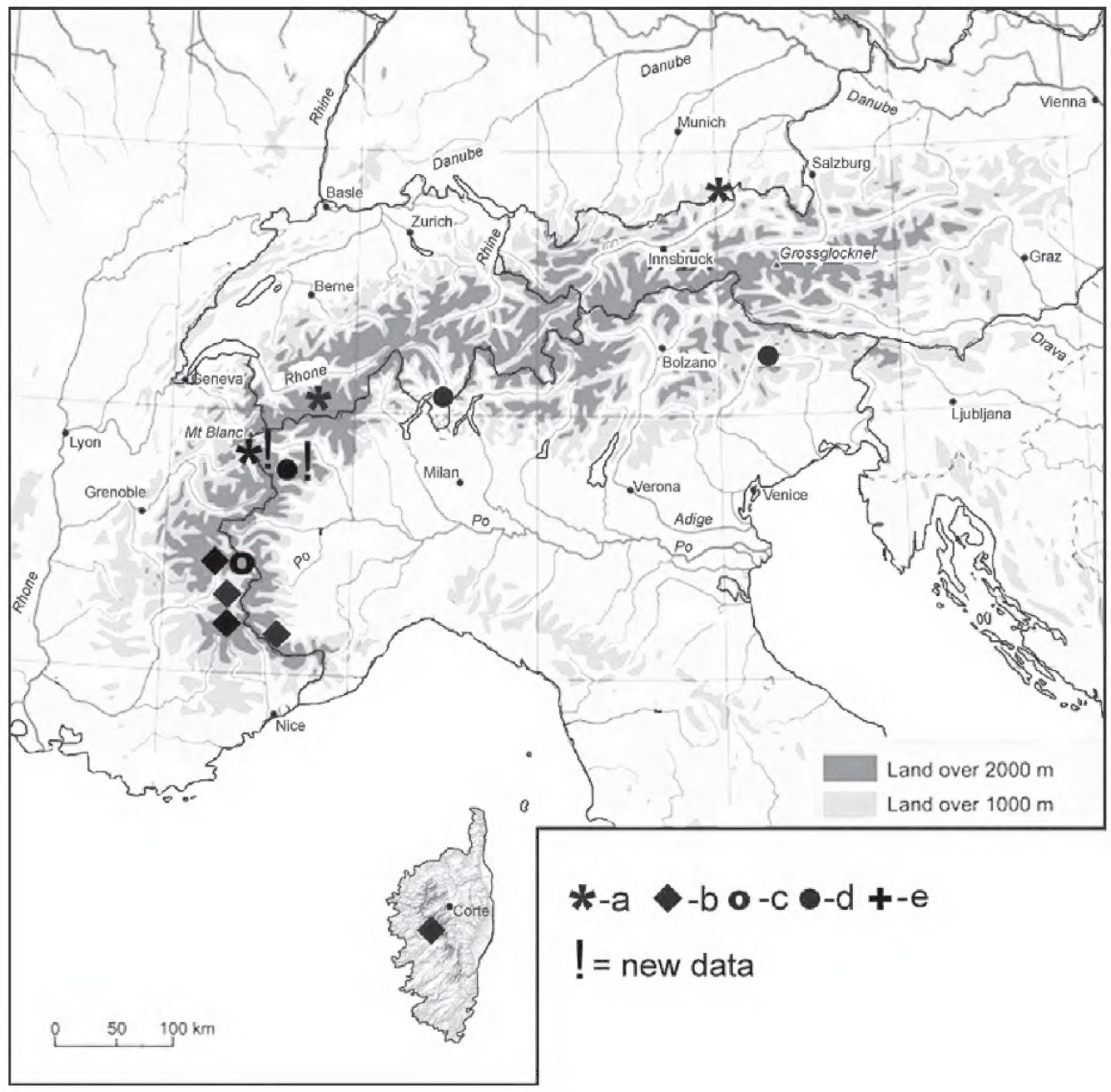

Fig. 1. Map showing the known distributions of *B. griseostriatus*-group species in the Alps and adjacent regions. **a** - *B. griseostriatus*. **b** - *B. ibericus*. **c** - *B. inexpectatus*. **d** - *B. alpestris*. **e** - *B. multilineatus* (Fig. 2). **!** - new data, other data from Dutton, Angus (2007) and Angus (2010).

reported here extend the known distributions of *B. griseostriatus* (De Geer, 1774) and *B. alpestris* (Dutton et Angus, 2007) in the Alps, and record *B. multilineatus* (Falkenström, 1922) from the French Pyrenees and *B. ibericus* (Dutton et Angus, 2007) from the Moyen Atlas of Morocco.

Material and methods

The material used for chromosome analysis is listed in Table 1, and the localities are shown on the maps in Figs 1 and 2. The methods are as described by Dutton and Angus (2007). The material is in the author's collection in the Natural History Museum, London.

Results

Mitotic chromosomes, arranged as karyotypes, are shown in Fig. 3.

***B. griseostriatus* (De Geer, 1774).**

Swedish reference material (first used by Dutton and Angus (2007) as Fig. 2, a, b) is shown in Fig. 3, a (plain) and Fig. 3, b (C-banded). A mid-gut nucleus from a female from the Little St Bernard Pass (French side) is shown in Fig. 3, c (plain) and Fig 3, d (C-banded). This material shows no chromosomal differences from the northern

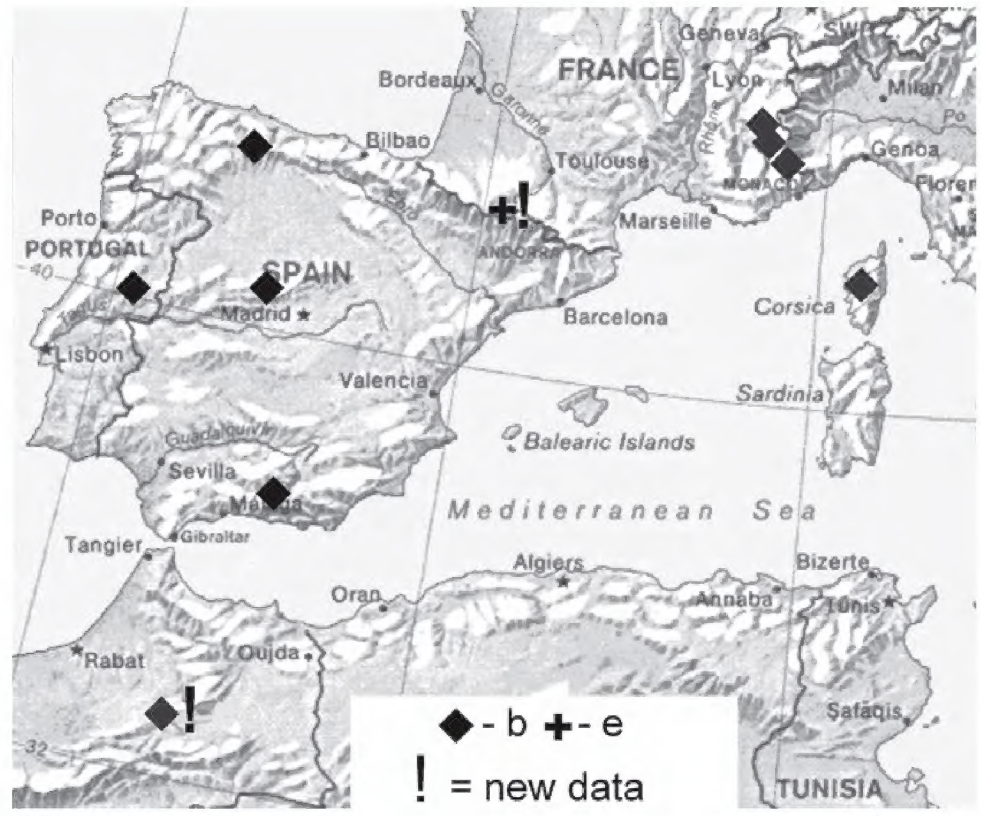

Fig. 2. Map of the Western Mediterranean area showing the known distributions of *B. ibericus* (**b**) and the Pyrenean locality for *B. multilineatus* (**e**). For explanation of symbols see caption to Fig. 1.

and Alpine karyotypes obtained from this species. The single male from near the Illsee (Switzerland) is not figured as its locality is very near the Le Louché localities from where material was figured by Angus (2010).

***B. multilineatus* (Falkenström, 1922).**

Plain and C-banded karyotypes of *B. multilineatus* from Clatteringshaws Loch, Scotland (first used by Dutton and Angus (2007) as Fig. 2, d, e) are shown in Fig. 3, e, f. Fig. 3, g, h shows a male karyotype from the Pyrenees, plain and C-banded, and Fig. 3, i, j shows a female karyotype from the Pyrenees, again plain and C-banded. These karyotypes appear identical in all respects to the Scottish material, and record *B. multilineatus* for the first time in central Europe.

The discovery of *B. multilineatus* in central Europe raises the question of its relationship to *B. alpestris*. Dutton and Angus (2007) noted that the only obvious difference between the karyotypes of the two species is the presence of one additional pair of very small autosomes in *B. multilineatus*. However, they considered it wisest to regard the two as separate species in view of their very different distributions and the distinctly larger male genitalia of *B. alpestris*. The discovery of *B. multilineatus* in the Pyrenees narrows the difference between the distributions of the two species, and, along with the new material of *B. alpestris* (see below) allows more careful comparison of their genitalia. Parameres of Swedish and Scottish *B. multilineatus* are shown in Fig. 4, e, f, while a Pyrenean specimen is shown in Fig. 4 g. The Pyrenean specimen appears conspicuously small. But the beetle itself is only 4.15 mm long, as against 4.4 mm for the Scottish male and 4.3 for the Swedish one. In fact, the Scottish paramere, even allowing for its somewhat distorted appearance (due to drying), does not appear any bigger than the Pyrenean one. The parameres of the two Pyrenean males studied both appear rather more elongate than those of Scottish and Swedish specimens. Parameres of two *B. alpestris* from the Colle del Nivolet are shown in Fig. 4, c, d. These parameres, mounted fresh

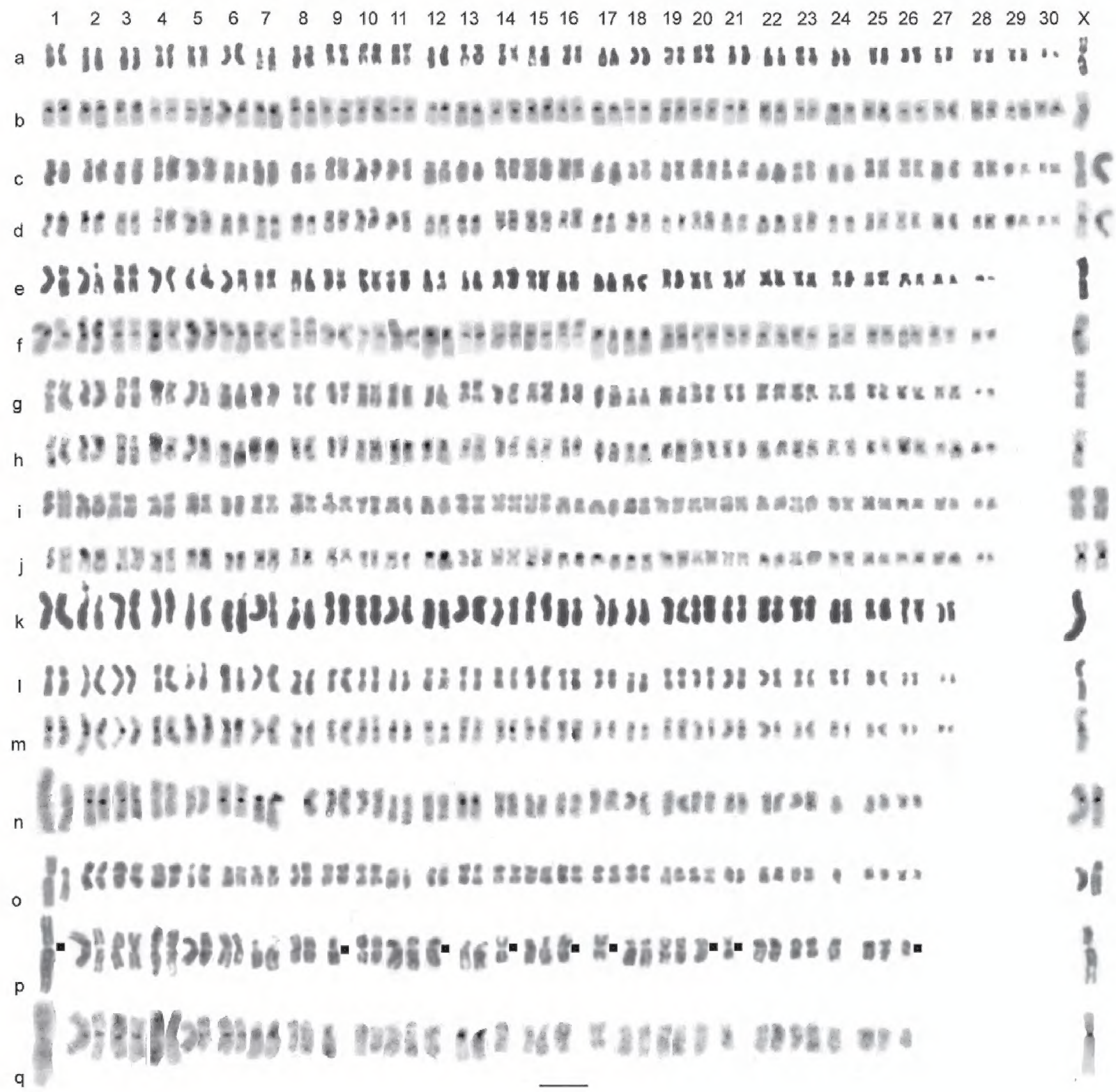

Fig. 3, a - q. Mitotic chromosomes of *Boreonectes griseostriatus*-group species, arranged as karyotypes. **a - d -** *B. griseostriatus*; **a** - ♂, Öregrund (Sweden), plain, **b** - ♂, Järnäs (Sweden), C-banded; **c**, **d -** ♀, Col de Petit Saint-Bernard, **c** plain, **d** - the same nucleus C-banded. **e – j -** *B. multilineatus*; **e, f** - ♂♂, Clatteringshaws (Scotland), **e** - plain, **f -** C-banded; **g, h -** ♂, pool by L. Oncet, Pyrenees, **g** - plain, **h** - the same nucleus, C-banded; **i, j** - ♀, pool by L. Oncet, **i -** plain, **j -** the same nucleus C-banded. **k - m -** *B. alpestris*; **k** - ♂ paratype, Falcade (Italy), plain; **l, m -** ♂, Colle del Nivolet, **l** - plain, **m** - the same nucleus C-banded. **n – q -** *B. ibericus*; **n** - ♀ paratype, C-banded, Lac de Lauzet Supérieur (France); **o** - ♀, Col du Zad, plain; **p, q** - ♂, incomplete nucleus, **p** - plain with the suggested positions of missing chromosomes marked by black squares, **q** - the same nucleus, C-banded. Bar = 5 μm.

into DMHF aqueous mountant and therefore undistorted by drying, are far clearer than the badly distorted ones figured by Dutton and Angus (2007, Fig. 5, d, e) and confirm the larger genitalia of *B. alpestris* compared with those of *B. multilineatus*. The two beetles

Fig. 4, a - g. Photomicrographs of parameres of *B. griseostriatus*-group species. **a -** *B. griseostriatus*, Öregrund (Sweden) (shown as Fig. 5**, a** in Dutton, Angus (2007)). **b** - *B. griseostriatus* var *nigrescens* Favre, pool above Le Louché, Switzerland. **c, d** - *B. alpestris*, Colle del Nivolet. **e - g -** *B. multilineatus*. **e** - Åmsele (Sweden) (shown as Fig. 5, b in Dutton, Angus (2007)). **f** - Clatteringshaws (Scotland), a small specimen. **g** - pool by Lac d'Oncet. Bar = 0.5 mm.

are both about 4.15 mm long. The parameres appear similar, in size and shape, to those of *B. griseostriatus* (Fig. 4, a, b).

***B. alpestris* (Dutton et Angus, 2007).**

The karyotype of a male paratype, from Falcade, Italy, figured by Dutton and Angus (2007) as Fig. 2 f, is shown in Fig. 3 k. Fig. 3 l, m shows a karyotype from a male from the Colle del Nivolet, plain and C-banded. This is the first time C-banded material of *B. alpestris* has become available. The extent and arrangement of the C-banding is very similar to that shown by *B. multilineatus* (Fig. 3, e-j). Comparison of the parameres of *B. alpestris* and *B. multilineatus* is given above, and confirms the view that *B. alpestris* is a species distinct from *B. multilineatus*.

***B. ibericus* (Dutton et Angus, 2007).**

The C-banded karyotype of a French male paratype originally figured by Dutton and Angus (2007) as Fig. 2 m, is shown in Fig. 3 n. Fig. 3 o shows a complete female karyotype from the Col du Zad, Morocco, while an incomplete male karyotype from the same locality is shown, plain and C-banded, in Fig 3 p, q. The suggested positions of the missing chromosomes are marked with black squares in Fig. 3 p. The reason for this incomplete karyotype is that when the first batch of preparations were made, in late April and early May, room temperature was rather low (about 17° C.) and I was unable to make a satisfactory alteration to my C-banding protocol for these beetles, even though I was successful with others (e.g. *Aphodius* (Scarabaeoidea)). By the time room temperature had reached the low 20s (in early June) the remaining two beetles, both male, though still alive, were in poor condition with very little cell division in the mid gut. Nevertheless, C-banding was now successful. The pattern of the C-banding is interesting, and agrees with the results obtained from Corsican material (Angus, 2010) in having prominent C-bands on autosome pairs 2, 3, 6, 7 and 13, as well as on the X chromosome. The French specimen has an additional pair of C-bands on autosome pair 8.

Two further features of the Moroccan material are of note. The material comprised eight beetles, of which seven gave definitive karyotypes. Of these, six are heterozygous for the fusion-fission polymorphism involving

autosome pairs 1 and 24, while the seventh specimen has the chromosomes homozygous unfused. The second feature of note is the conspicuously large size of the beetles – the three males range in length from 4.4 - 4.5 mm, and the five females from 4.5 - 4.9 mm. Dutton and Angus (2007) give the size range for *B. ibericus* (both sexes) as 3.8 - 4.7 mm. There is no feature of the Moroccan karyotypes giving any suggestion that they are not the same as those of European material.

Discussion

In terms of geographical distribution, the most surprising discovery reported here is the presence of *B. multilineatus* in the Pyrenees. From the totality of its distribution, the expected species was *B. ibericus*, which may well occur in other parts of the mountain range. The presence of *B. multilineatus* in the Pyrenees raises the possibility of its occurring more widely in northern Spain. In view of this I checked the single male *B. ibericus* from the Puerto de los Señales in the Cantabrian Mountains (Dutton, Angus, 2007), and it is true *B. ibericus*, homozygous for the fusion of autosome pairs 1 and 24. Thus the Pyrenean population is best regarded as a glacial relict, comparable with the Alpine populations of *B. griseostriatus*. The presence of *B. multilineatus* in the Pyrenees and *B. griseostriatus* in the Alps is in accord with the more western distribution of *B. multilineatus* in Scandinavia and the northern British Isles.

The new records for *B. griseostriatus* and *B. alpestris* give westward extensions of their known ranges, this being particularly striking in the case of *B. alpestris*. The distributions of their known populations (Fig. 1) show both species widely distributed from east to west, with *B. alpestris* consistently to the south of *B. griseostriatus*. The main unanswered question, at least as far as distributions in the western Alps are concerned, is the distribution of *B. inexpectatus* (Dutton et Angus, 2007). At present this species is known only from the Lac de Lauzet Inférieur, the smaller and higher of the two Lauzet lakes. The larger lake has *B. ibericus*. It seems possible that *B. inexpectatus* may occur in the Massif du Pelvoux, west of Briançon. The Moroccan record of *S. ibericus* shows this species to have a wide and consistent distribution in SW Europe and the adjacent part of North Africa. It is unfortunate that to date no material has been available from the Italian Apennines. The species here could be *B. ibericus* (derived from the Alpes Maritimes), *B. alpestris* (from the Alps further east), *B. macedonicus* Georgiev, 1959 (flown across the Adriatic) – or something completely different.

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